Simulation of the Background and SNO Detector Response in the Presence of the Neutral Current Detector Array

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The SNO detector is sensitive to all flavors of neutrinos through the neutral-current (NC) channel:

$$\nu_x + d \rightarrow n + p + \nu_x$$

By comparing the charged-current (CC) signal, which is contributed solely by ν_e, to this NC signal, SNO can test the neutrino oscillation hypothesis in a model independent way. One of the proposed methods to measure the NC neutron signal is to deploy 96 strings of ^{3}He proportional counter on a 1-m square lattice. The presence of this Neutral Current Detector (NCD) array will increase the radioactive background in the SNO detector volume, and obscure the Čerenkov light by absorption and scattering from the NCD body. We used the Parallel Distributed Systems Facility (PDSF) at the National Energy Research Scientific Computing Center (NERSC) to simulate with high statistics various signals in SNO.

By doing detailed simulations, we studied various systematics due to the light loss in the presence of the NCD array. For example, we demonstrated that this effect does not affect our ability to reconstruct the direction of the event. A comparison of the reconstructed event angular distribution in the pure D_2O and the NCD-installed running scenarios is shown in Figure 1.

This year we have continued our effort of accumulating Monte Carlo background events in the filled detector scenario using PDSF. These events include $\beta-\gamma$'s from different components of SNO and the NCD array. The generation of $\beta-\gamma$'s is very computational intensive, but the availability of the PDSF allows us to accumulate the required statistics at a much accelerated pace. Some of the simulation results are shown in Figure 2.

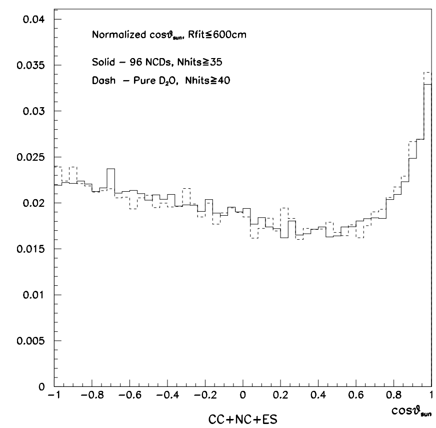

Figure 1: This plot shows that the presence of the NCD array does not affect the ability to separate the CC, NC and elastic scattering (ES) angular distribution of the neutrino signal. The abscissa is the cosine of the open angle between the fitted event direction and the Sun's direction.

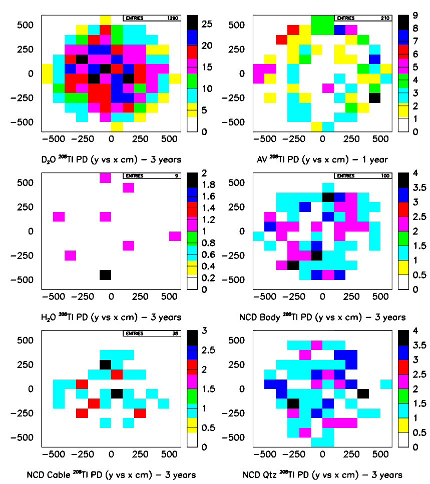

Figure 2: These graphs show the distribution of neutron capture by the NCD array. The pixels in the graphs represent a NCD string. Each panel represents $\beta-\gamma$ originating from different components of the detector.